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(54) Abstract Title
Analysing tactical data link messages

(57) The application describes a method of analysing digital data link messages, comprising the steps of:
a) receiving a plurality of data link messages;
b) assigning each data link message to one of a plurality of message groups such that each group contains data link messages of a specific message type (format);
c) within a group,
 (i) tabulating the messages so as to align corresponding fields;

For each field type, it is preferred to display a list of field contents within that type, filtered to remove repeated incidence of the same content. Thus, the user is presented simultaneously with a summary of the common entries for a particular field type and any spurious or unusual entries which are highlighted. It is also useful to filter the lists to remove repeated incidence of content falling with a specified narrow range. This could be more useful for continuously variable data types such as latitude or longitude data. This is particularly applicable to tactical data link messages, e.g. between aircraft and ground stations.

Fig 2

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1995

GB 2333672 A

Fig 1

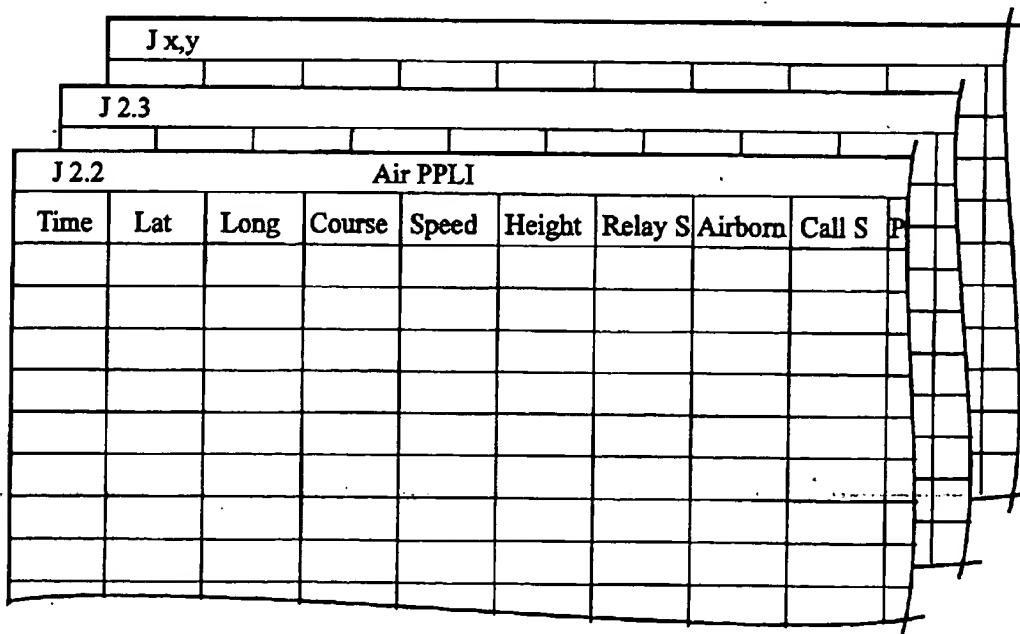
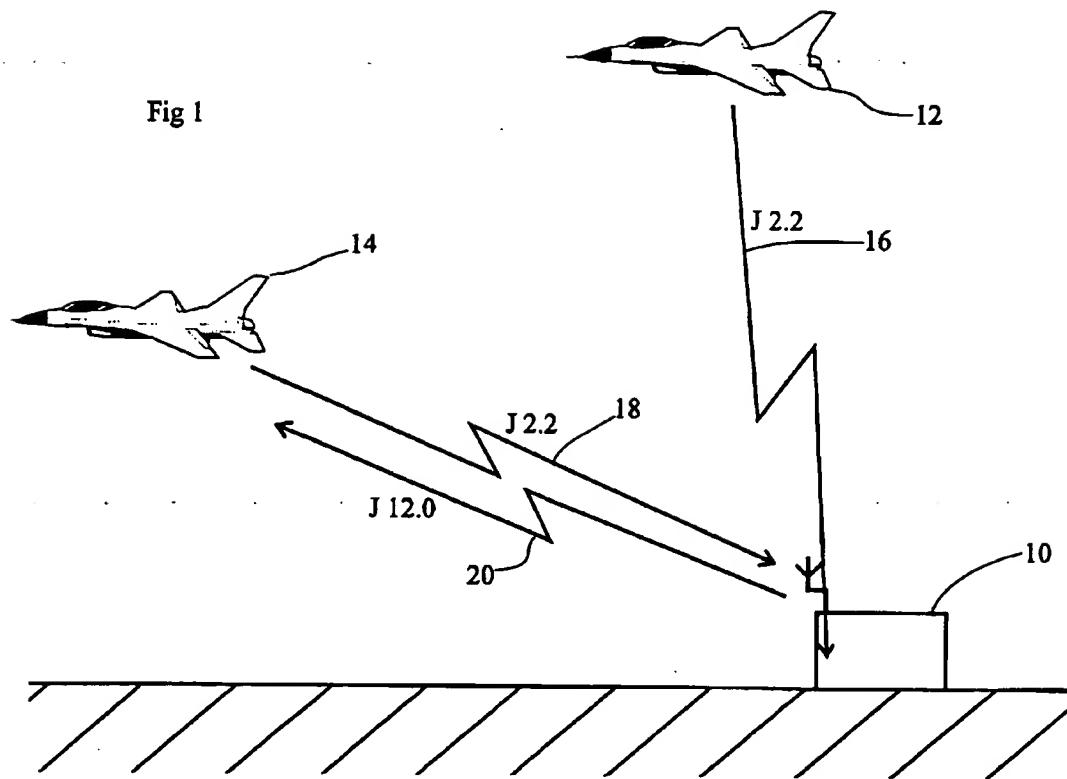


Fig 2

WEST

Air PPLI									
Time	Latitude	Longitude	Course	Speed	Height	Relay	Airborne Status	Voice Call Sign	Platform Type
13:28:25	51.259	-0.707	25	515	12015	Inactive	Airborne	TX01	F-16
13:28:37	51.27456	-0.69547	25	519	12020	Inactive	Airborne	TX01	F-16
13:28:49	51.29024	-0.68385	25	502	12057	Inactive	Airborne	TX01	F-16
13:29:01	51.30595	-0.67221	25	522	12103	Inactive	Airborne	TX01	F-16
13:29:13	51.32172	-0.6053	26	522	12116	Inactive	Airborne	TX01	F-16
13:29:25	51.33736	-0.64841	30	524	12161	Inactive	Airborne	TX01	F-16
13:29:37	51.35248	-0.63453	31	526	12210	Inactive	Airborne	TX01	F-16
13:29:49	51.36751	-0.62018	31	529	12223	Inactive	Airborne	TX01	F-16
	J2.2	J2.3	J2.4						

WEST

Air PPLI

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	10010	10011	10012	10013	10014	10015	10016	10017	10018	10019	10020	10021	10022	10023	10024	10025	10026	10027	10028	10029	10030	10031	10032	10033	10034	10035	10036	10037	10038	10039	10040	10041	10042	10043	10044	10045	10046	10047	10048	10049	10050	10051	10052	10053	10054	10055	10056	10057	10058	10059	10060	10061	10062	10063	10064	10065	10066	10067	10068	10069	10070	10071	10072	10073	10074	10075	10076	10077	10078	10079	10080	10081	10082	10083	10084	10085	10086	10087	10088	10089	10090	10091	10092	10093	10094	10095	10096	10097	10098	10099	100100	100101	100102	100103	100104	100105	100106	100107	100108	100109	100110	100111	100112	100113	100114	100115	100116	100117	100118	100119	100120	100121	100122	100123	100124	100125	100126	100127	100128	100129	100130	100131	100132	100133	100134	100135	100136	100137	100138	100139	100140	100141	100142	100143	100144	100145	100146	100147	100148	100149	100150	100151	100152	100153	100154	100155	100156	100157	100158	100159	100160	100161	100162	100163	100164	100165	100166	100167	100168	100169	100170	100171	100172	100173	100174	100175	100176	100177	100178	100179	100180	100181	100182	100183	100184	100185	100186	100187	100188	100189	100190	100191	100192	100193	100194	100195	100196	100197	100198	100199	100200	100201	100202	100203	100204	100205	100206	100207	100208	100209	100210	100211	100212	100213	100214	100215	100216	100217	100218	100219	100220	100221	100222	100223	100224	100225	100226	100227	100228	100229	100230	100231	100232	100233	100234	100235	100236	100237	100238	100239	100240	100241	100242	100243	100244	100245	100246	100247	100248	100249	100250	100251	100252	100253	100254	100255	100256	100257	100258	100259	100260	100261	100262	100263	100264	100265	100266	100267	100268	100269	100270	100271	100272	100273	100274	100275	100276	100277	100278	100279	100280	100281	100282	100283	100284	100285	100286	100287	100288	100289	100290	100291	100292	100293	100294	100295	100296	100297	100298	100299	100300	100301	100302	100303	100304	100305	100306	100307	100308	100309	100310	100311	100312	100313	100314	100315	100316	100317	100318	100319	100320	100321	100322</

ANALYSING TACTICAL DATA LINK MESSAGES

The present invention relates to a method of analysing data link messages. It is particularly useful for detecting interoperability conflicts between the various sources of such messages. In this application, the description is directed to the interpretation of tactical data link messages, but the principle of the invention can be applied to like messages.

Tactical data links operate by exchanging messages between military units such as aircraft, ships, ground stations etc, which are synchronised in a radio network. Messages are transmitted in a digital form and consist of a stream of data bits formatted according to certain rules. These rules lay down that messages have a fixed format dependent on their message type. Different message types are intended to contain different information. For example, a track message will contain position and velocity information of (for example) an aircraft, whilst a status message will contain fuel data and weapons status of the aircraft. At present, approximately fifty different types of messages are defined for each link.

The message types and formats for each type are set down according to NATO rules and in theory a platform conforming to those rules should therefore be able to communicate with any other platform which also follows those rules. In other words, the platforms are fully interoperable and can

communicate with each other satisfactorily. In practice, the rules are inevitably insufficiently comprehensive to cover every eventuality. There is therefore scope for variation between different platform implementations, and these variations typically lead to interoperability problems. For example, a receiving platform may require that an incoming message contains certain information whereas the transmitting platform for some reason does not include that information. This would result in the receiving platform discarding that message as it did not meet its processing rules.

Interoperability problems such as this can be discovered by comparing the different platform implementations with reference to their build specifications. However, the specifications themselves may be unclear and the procedure would in any case be lengthy and difficult. It is more usual for interoperability problems to be discovered during a trial when the messages are recorded and their contents matched against expected events in each platform.

The difficulty with this latter approach is that data is generated by tactical data links at a very high rate. It is normal to generate approximately 20 MB of data during a two hour flight by a single platform. This can be compressed for transmission, but for analysis will obviously need to be decompressed. A lengthy trial with a significant number of platforms will clearly generate a *prima facie* unmanageable volume of data.

It is however essential that interoperability problems are identified in order to allow their resolution. Such difficulties could significantly impair the effectiveness of armed forces in a conflict situation, the implications of which are clear.

At present, data is sorted chronologically and placed into a database. The sheer volume of data and the wide range of information that may be included within a specific message field due to the large number of message

formats means that direct inspection of the data is not physically possible on any significant scale. However, databases allow a user to present queries, which are essentially filters to select those entries which meet certain criteria. Thus, a user can present the database with queries intended to illuminate interoperability conflicts.

The use of databases to analyse the data in this way has certain defects. It is immediately apparent to a user that the databases take a significant amount of time to analyse the data and respond to the query. Whilst this could in future be solved by applying ever greater processing power to the database, it would be useful to be able to accelerate the process. At present, the various stages necessary to convert the data into a form readable by the database, enter it into the database, select appropriate queries and obtain responses and analyse those responses means that, at best, results are available several days after the trial. It would be useful if those results were available at the post-trial debrief. As this is held a matter of hours after the trial end, whilst operators memories are still fresh, this is simply not practical at present.

Existing databases also suffer from a more fundamental flaw. It is up to the user to generate queries, and therefore this requires an a priori knowledge of the type of interoperability conflicts likely to arise. The user is not generally in a position to detect unexpected interoperability errors, as the raw data cannot feasibly be inspected and the processing time required rules out the use of a large number of speculative queries aimed at detecting unlikely or unsuspected conflicts. Speculative queries also require the user to have an intimate knowledge of the type of content in particular message fields, in order to detect unusual entries. This again cannot be guaranteed, and is clearly unlikely in the case of unsuspected conflicts.

The present invention seeks to provide a more intuitive analysis method for data link messages which is capable of providing speedier

analysis.

The present invention therefore provides a method of analysing data link messages, comprising the steps of:

- a) receiving a plurality of data link messages;
- b) assigning each data link message to one of a plurality of message groups such that each group contains data link messages of a specific message type;
- c) within a group,
 - (i) tabulating the messages so as to align corresponding fields;
 - (ii) displaying the tabulated data.

The processing is preferably applied to all groups, but may be applied to a single group if it is known that this is the source of problems.

It will clearly be preferable for a group to contain all data link messages of a specific message type.

For each field type, it is preferred to display a list of field contents within that type, filtered to remove repeated incidence of the same content. Thus, the user is presented simultaneously with a summary of the common entries for a particular field type and any spurious or unusual entries. For example, if an entry normally contained a number between 1 and 12, for example, this list would comprise a random scattering of numbers in this range. If it also included a value such as 87 or a text value then at least one platform within the trial is clearly transmitting an incompatible message. It is likely that that message has a different meaning or is for some reason erroneous. This type of analysis does not require the operator to be aware a priori of the likely message content.

It is further preferred to allow the group to be filtered so as to display

only messages having a particular content for that field type, the content having been selected from the list. This enables an immediate selection to be made of erroneous or unusual entries in the list, which will then highlight the message or messages containing that entry. This would then enable the user to identify the platform or platforms generating those messages and institute appropriate corrective action.

A small modification to the above which may on occasions be useful is for the lists to remove repeated incidence of content falling with a specified narrow range. This could be more useful for continuously variable data types. It could for example be applied to latitude or longitude data to identify messages being received from platforms in an incorrect theatre.

As mentioned above, it is particularly envisaged that the invention will be applied to tactical data link messages. However, the principle can be applied to other data links and the invention is not therefore limited in this respect.

Embodiments of the present invention will now be described by way of example, with reference to the accompanying Figures, in which:

Figure 1 shows the exchange of tactical data link messages;

Figure 2 shows the tactical data link messages arranged and displayed according to the present invention;

Figure 3 shows an arrangement similar to Figure 2 employing a commercially available programme; and

Figure 4 shows the data of Figure 3 being analysed.

Tactical data links operate by exchanging messages between units

(aircrafts, ships, ground stations) which are synchronised in a radio network. Several different links are implemented, and are known as Link x where x is a number, Link 11, Link 16 etc. The different links use different radio signals and different radio sets to transmit and receive information. The messages are transmitted in digital form, consisting of a stream of data bits formatted according to rules set out in the Link standard. For Links such as Link 16, the messages are transmitted at a high rate and contain information accurate to within a few seconds.

The messages are formatted as different types, each type having a fixed format and containing similar information. The different message types have completely different formats and contain different information. For example, the types may consist of a track message, which contains position and velocity of a track, and a status message which contains fuel and weapons status of an aircraft. Within the framework of Link 16, some 50 different types of message are defined.

Within the structure of Link 16, each platform is assigned time slots of 7.8 ms duration and transmits messages only in those slots (but not necessarily in all of them). Messages may be transmitted regularly at defined intervals, or as "one offs" resulting from some operator action. Messages can be one of about 50 different types, which correspond to different possibilities for information exchange. For Link 16, each message type has a unique designation as a two part number of the form x,y. Thus, there are 256 different designations possible, of which approximately 50 are used, as mentioned above. Each message may contain between about 50 and 300 bits of information. The message is split into a number of fields which contain information relevant to the use of that particular message. For example, a track message will contain fields for latitude, longitude, speed, aircraft type etc. The representation of each field is fixed for a particular message type, so that a message can be decoded if the structure is known and the message type received. Some examples of messages are

given below.

Number	Name	Use
J0.0	Initial Entry	Allows units to synchronise to the network
J2.2	Air PPLI	Transmitted by Link 16 equipped units to give precise positional and identification data
J3.2	Air Track	Transmitted by command and control units to disseminate track data on the network
J12.0	Mission Assignment	One-off message used to assign a tactical mission to a controlled unit
J13.0	Airfield Status	Gives weather and other information about airfields

By way of example, the list of fields for an Air PPLI message includes latitude, longitude, course, speed, height, relay status, airborne status, voice call sign and platform type.

All tactical data links and certain other types of data link such as buses that connect processors in some data processing systems have a similar message structure.

A recording of a tactical data link will contain all messages that have been transmitted by all units with a certain time frame. The recording contains message of different types, ordered chronologically. The analysis tool must decode messages into fields and sort them. In the past, using text-based analysis tools, the messages have been sorted chronologically.

Figure 1 illustrates tactical data links in progress, transferring messages 16, 18, 20 to and from a ground station 10 and operating aircraft 12, 14.

Figure 2 shows the manner in which data is ordered and structured

according to the present invention. Thus, messages are first sorted by message type and grouped accordingly. Within a message group, they can be sorted chronologically if desired. The messages are then tabulated such that each field is displayed in an aligned relationship to other fields.

Figure 3 shows the same data displayed by a commercially available programme, Microsoft Excel. Microsoft is a registered Trade Mark. Markers 50 indicate that a drop down menu can be selected, as shown in Figure 4, to reveal all the discrete values within that field. Anomalous values such as that illustrated at 52 are clearly highlighted. Selection of these values from the field results in the programme automatically applying a filter aimed at selecting that or those messages. These messages can then be inspected individually to trace the source platform.

It will be apparent that use of the analysis method set out above enables unusual or spurious entries to be detected very quickly. Messages such as the Air PPLI type include a total of forty fields, so it will therefore take only a matter of seconds to look through the individual filter results and identify spurious or unusual entries. The tabulated storage method is also very much less unwieldy than a database, and therefore can be filtered to reveal the erroneous message much more quickly. In tests, analysis results have been available in time for the post-exercise debrief, a matter of hours. This compares with the several days required to analyse the same data through the use of a database.

It will be appreciated that many variations could be made to the above described example without departing from the scope of the present invention.

CLAIMS:

1. A method of analysing data link messages, comprising the steps of:
 - a) receiving a plurality of data link messages;
 - b) assigning each data link message to one of a plurality of message groups such that each group contains data link messages of a specific message type;
 - c) within a group,
 - (i) tabulating the messages so as to align corresponding fields;
 - (ii) displaying the tabulated data.
2. A method according to claim 1 wherein the processing is applied to all groups.
3. A method according to claim 1 or claim 2 wherein each group contains all data link messages of a specific message type.
4. A method according to any preceding claim wherein a list of field contents is displayable for each field type, filtered to remove repeated incidence of the same content.
5. A method according to claim 4 wherein the list is sorted.
6. A method according to claim 4 or claim 5 wherein the group is filtered so as to display only messages having a particular content for that field type, the content having been selected from the list.
7. A method according to any one of claims 4 to 6 wherein the lists are filtered to remove repeated incidence of content falling with a specified range.

8. A method according to any preceding claim in which the data link messages are tactical data link messages.
9. A method of analysing data link messages substantially as herein described with reference to and/or as illustrated in the accompanying figures.



Application No: GB 9801669.4
Claims searched: 1-9

Examiner: Keith Williams
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Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4P (PEUL, PEUX, PEV, PPD); H4L (LFM)

Int Cl (Ed.6): H04L 12/26; H04B 17/00; G06F 17/24, 17/30, 17/40

Other: Online WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2306863 A	Fujitsu - see abstract (& US 5740355)	1-3
A	GB 2295299 A	Enterprise Network Services Inc. - see abstract	1
X	EP 0720108 A1	Aegis Star Corp. - see page 3, column 2, lines 9-15; abstract	1-3
X	US 5615323	Concord Communications Inc. - see abstract	1
A	US 5504863	Fujitsu - see abstract	1
X	US 5270705	US Navy - see eg columns 4 and 5	1-3
X	US 4907159	US Philips - see abstract (& EP 0290679)	1-3

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
& Member of the same patent family		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.